

xxx

25/03/2012

The connection between model performance on the CCMVal transport diagnostics and simulated sensitivity of ozone to chlorine change

Anne Douglass¹, Richard Stolarski², Luke Oman¹, Susan Strahan³

¹ NASA Goddard Space Flight Center

² Johns Hopkins University

³ Universities Space Research Association

Contact: rstolar1@jhu.edu

The chemistry climate models that contributed simulations for past and future ozone evolution to the 2010 Scientific Assessment of Ozone Depletion were subject to extensive evaluation by the SPARC (Stratospheric Processes and their Role in Climate) CCMVal (Chemistry-Climate Model Validation) activity. The sensitivity of ozone to changes in composition and climate varies among the models, but the relationship between these variations and the model evaluations of CCMVal is not obvious. We have learned that the transport evaluation can be used to interpret the comparisons between observed and simulated columns of chlorine reservoirs, hydrochloric acid (HCl) and chlorine nitrate (ClONO₂); these comparisons were part of the CCMVal evaluation of chemistry. The simulations with best performance on the transport diagnostics most faithfully reproduce the evolution and seasonal variation of the chlorine reservoirs as observed at NDACC (Network for Detection of Atmospheric Composition Change) stations (NyAlesund 78.9N, Kiruna 67.8N, Harestua 60.2N, Jungfraujoch 46.6N, Toronto 43.6N, Kitt Peak 31.9N, Izana 28.3N, Mauna Loa 19.5N, Lauder 45S and Arrival Heights 77.8S). In the simulations, the HCl in the lower stratosphere depends on total inorganic chlorine (Cly) and partitioning between HCl and ClONO₂. Total inorganic chlorine depends on the fractional release of chlorine from source gases, and ratio of ClONO₂ to HCl is inversely dependent on methane and varies quadratically with ozone. Simulated HCl from various models may agree with observations even though Cly is in error, partitioning is in error, or both. Simulated ozone sensitivity to chlorine is shown to be greater for models that produce larger values of chlorine nitrate for background chlorine levels, and vice versa. Comparisons with the NDACC data show why the models with 'best' transport have similar sensitivity to chlorine change. The realistic evolution of the simulated HCl and ClONO₂ columns suggests realistic levels of Cly in the lower atmosphere. In addition, the wide range values for the sensitivity of ozone to chlorine obtained from the CCMVal simulations is explained by the wide range in lower atmospheric columns of ClONO₂ and the concomitant wide range of levels for chlorine monoxide.

Print this page